

International Atomic Energy Agency

INDC(NDS)-180/LNA

INDC

INTERNATIONAL NUCLEAR DATA COMMITTEE

REPORT OF THE NUCLEAR DATA SECTION
TO THE INTERNATIONAL NUCLEAR DATA COMMITTEE
SEPTEMBER 1984 TO FEBRUARY 1986

A. Lorenz, Editor

April 1986

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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Abstract

This progress report of the IAEA Nuclear Data Section covers the 18-months period September 1984 to February 1986. It describes past, current and planned activities of the Section and presents the status of its nuclear data centre services and technology transfer.

Reproduced by the IAEA in Austria
April 1986

86-01783

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List of Abbreviations

A+M	Atomic and molecular
ADABAS	Data base management system in use at IAEA
CAJaD	Centre for Data on the Structure of the Atomic Nucleus and Nuclear Reactions of the USSR State Committee on the Utilization of Atomic Energy, located at the Kurchatov Institute
CBNM	Central Bureau for Nuclear Measurements, located at Geel, Belgium
CCDN	Centre de Compilation de Donnees Neutroniques, same as NDCC Neutron Data Compilation Centre of the OECD Nuclear Energy Agency at Saclay near Paris; now part of NEA Data Bank
CDFE	
CIAMDA	Computerized Index to Literature on Atomic and Molecular Collision Data Relevant to Fusion Research
CINDA	Computerized Index of Neutron Data, a specialized bibliography and data index on neutron nuclear data compiled jointly by NNCSC, NDCC, NDS and CJD
CINDU	A Catalogue of Numerical Nuclear Data Libraries available from NDS
CJD	Centr po Jadernym Dannym, the USSR Nuclear Data Centre at F.E.I. Obninsk
CODATA	Committee on Data for Science and Technology
CODEN	International code for the abbreviation of periodical titles used by ASTM, INIS and Chemical Abstracts
CPL	Computer Programme Library operated by NEA, and located at Ispra, Italy; now part of NEA Data Bank
CPND	Charged Particle Nuclear Reaction Data
CRP	Coordinated Research Programme
CSISRS	NNCSC' internal system for handling experimental data; the previous system was known as SCISRS
DASTAR	<u>D</u> ata <u>S</u> torage and <u>R</u> etrieval System used originally at IAEA/NDS
DBMS	Data Base Management System
EBCDIC	Extended Binary-Coded Decimal Interchange Code
EGAS	European Group for Atomic Spectroscopy

ENDF/B Evaluated Nuclear Data File of the United States

ENSDF Computer-based Evaluated Nuclear Structure Data File developed
by US/NDP

EWGRD European Working Group on Reactor Dosimetry

ESCAMPIG Europhysics Study Conference on Atomic and Molecular Physics
in Ionized Gases

EXFOR Exchange Format, initially developed for the international
exchange of neutron nuclear data, now being extended to
charged particle nuclear data

FIZ Fachinformationszentrum Energie, Physik, Mathematik GesmbH
located at the Kernforschungszentrum Karlsruhe in the Federal
Republic of Germany

FPND Fission Product Nuclear Data

IAEA/NDS Nuclear Data Section of the International Atomic Energy
Agency, also NDS

ICPEAC International Conference on the Physics of Electronic and
Atomic Collisions

ICTP International Centre for Theoretical Physics

IFRC International Fusion Research Council

INDC International Nuclear Data Committee

INDL/A IAEA Nuclear Data Library for Evaluated Neutron Reaction Data
of Actinides

INIS International Nuclear Information System, a bibliographic
system operated by the IAEA

IRDF International Reactor Dosimetry File

IWGRRM International Working Group on Reactor Radiation Measurements

JILA Joint Institute for Laboratory Astrophysics

JINR Joint Institute for Nuclear Research in Dubna, USSR

KACHAPAG Karlsruhe Charged Particle Group

KEDAK Karlsruhe Evaluated Neutron Data File

LIYaF Leningrad Institut Yadernoy Fiziki: Leningrad Nuclear Physics
Institute of the USSR Academy of Sciences

NDCC Neutron Data Compilation Centre (Centre de Compilation de
Donnees Neutroniques - CCDN) of the OECD Nuclear Energy Agency
at Saclay near Paris; now part of NEA Data Bank

NDP	Nuclear Data Project located at the Oak Ridge National Laboratory (also referred to as US/NDP)
NDS	IAEA Nuclear Data Section, Vienna
NEA	Nuclear Energy Agency of the OECD
NEA/DB	Nuclear Energy Agency of the OECD Data Bank (previously NDCC)
NEACRP	Committee on Reactor Physics of the Nuclear Energy Agency of the OECD
NEANDC	Nuclear Data Committee of the Nuclear Energy Agency of the OECD
NNCSC	US National Neutron Cross Section Centre at the Brookhaven National Laboratory, Upton, N.Y. (now NNDC)
NND	Neutron Nuclear Reaction Data
NNDC	National Nuclear Data Centre of the United States
NRDC	Nuclear Reaction Data Centres
NSDD	NSD data = Nuclear Structure and Decay Data
OECD	Organization for Economic Cooperation and Development
RCN	Now ECN = Energy Research Foundation at Petten in the Netherlands
RIKEN	Institute of Physical and Chemical Research, Saitama, near Tokyo, Japan
SCISRS	Sigma Centre Information Storage and Retrieval System
SOKRATOR	Soviet Evaluated Neutron Data File Format
TND	Transactinium Isotope Nuclear Data
UKNDL	UK Nuclear Data Library
WRENDA	World Request List for Nuclear Data published by the IAEA
ZAED	Zentralstelle fuer Atomkernenergie-Dokumentation: Nuclear documentation and information centre for the Federal Republic of Germany; now FIZ

Programme Summary

J.J. Schmidt
Head, IAEA Nuclear Data Section (NDS)

This progress report on the activities and services of the IAEA Nuclear Data Section covers the eighteen months period from September 1984 to February 1986.

In this reporting period there was only a small turnover of NDS staff. In September 1985, John Hughes, atomic physicist/programmer in the Section's Atomic and Molecular Data Unit, after only one year of service with the Agency, was called back by his home University in Belfast, Northern Ireland, and could only be replaced in April 1986 by James J. Smith, also atomic physicist/programmer and former staff member of the IAEA Safeguards Department. At the end of January 1986, after three years of service with the Agency, Madhu K. Mehta was called back by his home authorities and will be replaced in Spring 1986 by Dr. Wang Dahai, Head of the Physics Department of the Institute of Atomic Energy, Beijing, People's Republic of China.

The reporting period was marked by exhaustive evaluations of the Interregional Technical Co-operation Project for Nuclear Data Techniques and Instrumentation (TC/INT/1/018) and improved co-operation with the Physics Section in the planning and implementation of technical assistance projects and training courses of mutual interest. For the first time a meeting was convened which performed a comprehensive review of nuclear and atomic data requirements for radiotherapy and related radiobiology. Further highlights have been intensive planning and implementation work on the production of nuclear data handbooks and associated computer files for specialized applications, the implementation of a decentralized input system for the Agency's CINDA publication, and an increasing use of more cost-efficient personal computers and adaptation of ENDF/B- processing codes and specialized data files to IBM PCs. The number of requests received and answered by NDS over the last few years has stabilized at an annual average figure of more than 700 or about three requests per working day.

As part of the Agency's evaluation of technical co-operation projects, the Interregional Project TC/INT/1/018 has undergone exhaustive evaluations through an in-house desk evaluation review followed by an "In-depth Field Evaluation" of the programme at six selected laboratories by outside experts chosen from a list of names recommended by the INDC. The field evaluation has resulted in a recommendation to continue the project in its second phase with a somewhat widened scope and a stronger emphasis on training in nuclear measurement techniques with neutron generators and small accelerators.

The Advisory Group Meeting on Nuclear and Atomic Data for Radiotherapy and Related Radiobiology was the first meeting ever held devoted to a detailed review of nuclear and atomic data applied in neutron, heavy ion and pion therapy, with an emphasis on the status of neutron spectra and cross sections and electron stopping power data in tissue equivalent materials.

Significant activity was devoted to the planning and production of handbooks and associated data files. The handbook on nuclear activation cross section data, a complete update and thorough revision of an earlier NDS handbook published in 1974, is now with the IAEA editors and will be published

in the second half of 1986. The results of the seven-year Coordinated Research Programme on "The Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data" will also be published in the course of 1986 as an edited IAEA Technical Report; these data represent the world-authoritative recommended heavy radionuclide decay data. Compilation work on the handbook of nuclear data for safeguards has started and a first tabulation of data readily available to NDS is planned to be published in 1986. A Consultants' Meeting on Nuclear Data for Applied Nuclear Geophysics held in Vienna in April 1986 as a follow-up to the first meeting in the field held in Krakow in October 1983, succeeded in defining the high priority requirements for nuclear data applied in the analysis of nuclear geophysics and nuclear geochemistry measurements; these should define the content of a planned handbook and data file of nuclear data for nuclear geology applications which has just been started.

In the field of nuclear standard reference data, the Advisory Group Meeting with the same title, held at BCMN Geel in Belgium in November 1984, expanded the scope of review to all nuclear standards reference data and, together with a Consultants' Meeting convened in May 1985, laid the foundation for a new short-term Coordinated Research Programme (CRP) aimed at producing a single international file of carefully evaluated standard γ -ray decay data to be universally used for detector energy calibration.

In the framework of the CRP on Validation and Benchmark Testing of Actinide Nuclear Data, detailed comparisons and testing of different evaluations were carried out and new full evaluations were made available by the USSR for ^{235}U and the major Pu isotopes. The CRP on Measurement and Analysis of 14 MeV Neutron Cross Sections brought together extensive data measurements and critical analyses of nuclear data measurement techniques. The final results of this CRP will be reviewed and summarized at the third and last Research Coordination Meeting in Dubrovnik, Yugoslavia, May 1986, and then be published as an IAEA Technical Document towards the end of the year.

In the framework of NDS data centre activities, the NDS CINDA system has been completely rewritten and the decentralized system for input to the IAEA CINDA publication has been implemented with each of the four contributing data centres maintaining its own partial master file and supplying it to NDS for the periodic CINDA publication. A new version of the IAEA Nuclear Data Library of neutron data evaluations, INDL/V(85), which contains revisions to almost all evaluations included in its previous version and several new evaluations, in particular from the People's Republic of China, has been issued. The data checking programs for evaluated data in ENDF/B format, EXFOR, CINDA and WRENDA were significantly updated to improve automatic error detection. A major effort has been undertaken to convert ENDF/B pre-processing codes to IBM personal computers and plans have also been made to implement smaller data files for specialized applications on PC's. This will offer NDS customers in smaller developing countries a more cost-effective data processing capability. A Workshop on nuclear data applications and reactor physics was held in February/March 1986 at the ICTP in Trieste (five weeks) and the Jozef Stefan Institute in Ljubljana, Yugoslavia (one week), and organized in co-operation with the ICTP and the Agency's Physics Section. A complementary four weeks Interregional Technical Assistance Training Course on the preparation of nuclear data for nuclear reactor calculations was held at the Bhabha Atomic Research Centre in Bombay, India, in April 1986.

Work in the area of atomic and molecular data for fusion was seriously curtailed by the unrecoverable loss of a professional atomic physics post, and the premature recall of the only atomic physicist/programmer, leaving the A+M Data Unit without staff for a period of six months. Although it was possible to maintain the publication of the International Bulletin on Atomic and Molecular Data for Fusion during that interim period, the creation of a file of evaluated numerical data was seriously delayed. In September 1985, an Advisory Group Meeting brought together plasma modellers and atomic physicists in a successful attempt to review the available atomic collision data relevant to fusion plasma modelling, with an emphasis on processes involving iron and its ions.

Finally, during the reporting period, NDS has hosted five cost-free staff, three of them supported under the Agency's fellowship programme. While most of them received training on special aspects of bibliographic and numerical data processing, they contributed significantly to the NDS programme by writing data reviews, producing and reviewing parts of the activation data handbook, and improving some of the evaluated data files.

A. INDC SECRETARIAT

A.1. Liaison Officers of the INDC

The following changes in the membership of INDC Liaison Officers have occurred in the course of this reporting period:

Netherlands Dr. H. Gruppelaar
has replaced Dr. M. Bustraan

Viet Nam Dr. Tran Quoc Thuong
new Liaison Officer

The current list of INDC Liaison Officers, comprising scientists from 48 Member States, is given in Appendix A.

A.2. List of INDC Correspondents and National Nuclear Data Committees

The current list of INDC correspondents for the exchange of nuclear data information is planned to be issued in April 1986. The report also contains the information on National Nuclear Data Committees which had been published separately in the past. This combined report will be published as INDC(SEC)-091/UN.

A.3. List of INDC Documents

The current list of INDC Documents received and distributed by the INDC Secretariat is to be published in April 1986 as report INDC(SEC)-092/UN. In an effort to help reduce the publication load of the Nuclear Data Section, the content of the List of INDC Documents has been reduced to include reports which have been published in the course of the preceding two years, instead of the preceding five years which were included in previous issues of this report.

A.4. Translation of Documents

Subject to available funds, the IAEA translates a limited number of INDC reports submitted. During 1984 and 1985, 28 nuclear data reports have been translated from Russian, Portuguese and Chinese, and distributed as INDC reports. Their full titles are given in the List of INDC Documents, INDC(SEC)-092/UN.

B. DATA ASSESSMENT AND RESEARCH COORDINATION

B.1. Data Status and Requirements

B.1.1. Nuclear Standards Reference Data. Advisory Group Meeting held on 12-16 November 1984, CBNM, Geel, Belgium.

The meeting was attended by 48 scientists including 3 observers from 15 Member States and 3 international organizations. The originals of eighteen review papers, forty-eight contributed papers, and the summaries of all plenary and working group sessions exceed more than 900 pages. Proceedings were published in a reduced form in IAEA-TECDOC-335.

The meeting brought together a representative group of specialists with the following objectives:

- to review the current status of evaluated standard reference data;
- to review the requirements of standard reference data;
- to summarize the progress in measurements, instrumentations, techniques and calculations of standard reference data and to specify the problems of inconsistency and accuracy of the data;
- to formulate specific technical recommendations for future work and its coordination, needed to improve the accuracy of the standard reference data.

Compared with previous meetings, held by the Agency in 1967 and 1972, in which only neutron standard data were discussed, the scope of this meeting has been extended to all nuclear standard reference data, including new standard data such as standard neutron energies. Special emphasis was given to recent experimental results for the standard reference data as well as to improvements in detectors and measuring techniques enabling a more accurate determination and use of standards. New evaluations of standard data, especially the ENDF/B-VI Standards File, as well as correlations and simultaneous evaluations of standard neutron cross-sections received full attention.

B.1.2. Radiation Damage Estimates for Reactor Structural Materials. Consultants' Meeting held on 20-22 May 1985, Santa Fe, N.M., U.S.A.

This meeting was attended by 14 scientists from nine Member States and one international organization. The major objectives of the meeting were:

- to review the status of displacement cross sections and the requirements for nuclear data needed for estimates of radiation damage in reactor structural materials, including also a discussion of the methodologies involved and of their uncertainties;
- to review the status of dosimetry cross sections required for the characterization of the radiation environment in fission and fusion reactors, as well as the status of covariance information for required data.

The proceedings of the meeting, published in INDC(NDS)-179, contain, in addition to contributed papers, the conclusions and recommendations related to nuclear data needed for neutron dosimetry, and radiation damage and gas production estimates for reactor structural materials.

B.1.3. Nuclear and Atomic Data for Medical Radiotherapy and related Radiobiology. Advisory Group Meeting held on 16-20 September 1985, TND, Rijswijk, The Netherlands.

This Advisory Group meeting was attended by 35 scientists from 9 Member States and three international organizations.

The meeting had the following specific objectives:

- to make an inventory of the available knowledge on nuclear and atomic data sets relevant to radiotherapy and related radiobiology,
- to identify and specify the needs for nuclear and atomic data and their accuracies,
- to stimulate new experimental and theoretical work to fill the identified gaps in nuclear reaction, decay and atomic data, and
- to formulate specific technical recommendations for future work.

The meeting

- identified the major gaps in neutron cross section data mainly for tissue materials for neutron energies between 20 and 100 MeV needed for neutron radiotherapy and for Kerma and neutron transport calculations in phantom and real tissues;
- emphasized the insufficient accuracy of stopping powers for electrons at energies below 10 keV, and the lack of stopping power measurements for tissue-equivalent plastic, polyethylen, nylon, and ions heavier than He (e.g. carbon and oxygen ions in organic materials) and other atomic data; and
- reviewed the status of nuclear data applied in pion and heavy ion therapy.

The meeting proceedings will be issued in the IAEA Technical Report Series in 1986. The summary and recommendations of the meeting were published in INDC(NDS)-175.

B.1.4. Nuclear Data for Geophysics Techniques. Consultants' Meeting convened by the IAEA Nuclear Data Section at IAEA Headquarters in Vienna, Austria, from 7 to 9 April 1986.

Compared with the two previous meetings on this topic held by the IAEA/NDS in 1983 and 1984, in which many nuclear data aspects were discussed, the scope of this meeting was focussed on the status of and the requirements for microscopic nuclear cross sections needed for the effective implementation of those nuclear geophysics methods which are based mainly on neutron induced gamma-ray (prompt and delayed) spectrometry applied to exploration, exploitation and processing of mineral resources.

The meeting reviewed the status of and requirements for microscopic nuclear cross sections for the production of prompt and delayed gamma-rays from thermal neutron capture as well as for the production of specific prompt and delayed gamma-rays from the (n,n'), (n,p), (n, α), (n,2n) and other appropriate reactions in the neutron energy range from threshold to 20 MeV.

B.1.5. Nuclear Data for Fusion Reactor Technology. Advisory Group Meeting scheduled to be convened on December 1-5, 1986, in Gaussig (near Dresden), German Democratic Republic, in co-operation with the Technical University of Dresden.

The objectives of this meeting will be:

- to identify changes (since 1978) in specific nuclear data requirements including required accuracies and priorities on the basis of benchmark testing of currently available nuclear data files and to compare the required with presently achieved data accuracies;
- to review recent measurements, evaluations and theoretical calculations of fusion relevant nuclear data;
- to identify and discuss measurements, compilations, evaluations and theoretical calculations required to satisfy the current and foreseeable nuclear data needs for fusion reactor technology;
- to formulate specific recommendations and measures for future activities and their coordination; and
- to encourage the exchange of data evaluation methods and evaluations themselves.

B.1.6. WRENDA 87/88

A revised issue of WRENDA, published last in November 1983, is planned to be published during 1987; a proposal to include requests for actinide decay data and for biomedical and geological nuclear data, as three additional and separate categories, is being considered.

NDS coordinates the compilation and publishes WRENDA on behalf of the four nuclear data centres. This world request list contains specific requirements for nuclear data needed for the development of fission and fusion reactors, and nuclear materials safeguards techniques. WRENDA 83/84 was published in November 1983 (distributed as INDC(SEC)-88/URSF report).

Following the recommendations of the NRDC meeting, Saclay, France, 9-11 October 1985, NDS is preparing draft guidelines for up-dating the WRENDA request list, including

- guidelines to exclude unrealistic and unreasonable requests, and
- guidelines for defining priorities of nuclear data related to different applications.

It is planned to circulate the guidelines to the INDC and nuclear data centres and national nuclear data committees in order to ensure a generally accepted procedure for preparing nuclear data requests.

B.1.7. Fission Product Newsletter

"Progress in Fission Product Nuclear Data" (FPND), the annual compendium of information about activities in the field of measurements and compilation/evaluation of FPND, continues to be published; the last issue of this publication (No. 11) was published in September 1985 as INDC(NDS)-168/GP.

In view of the relatively small changes in the contents of the annual contributions to this newsletter, and because of increasing workload in the Section, it was decided to change the publication frequency of this newsletter from annual to biennial. The 12th issue of this series will therefore be published in 1987.

B.2. Coordinated Research Programmes (CRP)

B.2.1. Measurement and Evaluation of Transactinium Isotope Decay Data.

The IAEA Coordinated Research Programme on the "Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data" ended in 1984, and the final report has been submitted for publication; it will be issued as an IAEA Technical Report in 1986 (see C.2.2.b).

The work of the CRP was performed by five groups experienced in decay data measurements, complemented by a number of individual contributions. Participants in the CRP met for the first time in April 1978; subsequent meetings have been held annually through 1984. The last meeting of this CRP was convened on 5-9 November 1984, at IAEA Headquarters in Vienna. The Summary report of this meeting was published as INDC(NDS)-164/GE.

The specific objectives of this project were to improve the quality and accuracy of heavy element and actinide decay data in order to:

- assess more accurately the effects of these data on the thermal and fast reactor fuel cycles;
- aid in the evaluation of nuclear waste management procedures;
- provide more reliable data for nuclear safeguards;
- extend the knowledge of actinide decay characteristics required in scientific research;
- and ultimately to arrive at a final set of decay data for the transactinium nuclides which would satisfy the required accuracies.

To achieve these objectives, the status of the existing data was reviewed annually, priorities were assigned, on-going measurements were coordinated and new ones initiated. Considerable emphasis was put on cooperation among the participating laboratories and on the intercomparison of the results. The CRP participants concentrated specifically on the measurement and evaluation of total and partial half-lives, and alpha particle and gamma ray emission probabilities, these being the broad categories of decay data emphasized at the Karlsruhe Advisory Group Meeting in 1975.

In the framework of this international cooperative effort, the CRP participants also contributed to the development of methodology and measurement techniques, and stimulated a number of measurements and evaluations at laboratories not directly involved in the IAEA project.

B.2.2. Measurement and Analysis of 14 MeV Neutron Cross Sections for Fission and Fusion Reactor Technology

The second research co-ordination meeting for this programme was held during 4-8 February 1985 at Chiang Mai, Thailand. The summary report and working group recommendations are published as INDC(NDS)-172/GI, [INT(85)-7]. Fourteen laboratories (6 research agreements and 8 research contracts) have been participating in this programme till the end of 1985. The Institute of Atomic Energy, Beijing, has joined as the fifteenth participant on a research agreement in December 1985.

The highlights of this second meeting were reports on extensive data measurements from Morocco, Bangladesh, and Vietnam amongst the research contract holders and from all the research agreement holding laboratories. The results of measurement on the nickel foils irradiated at the Lawrence Livermore National Laboratory (LLNL) as part of the intercomparison exercise were also reported. The detailed analysis of this intercomparison has been published as an INDC report [INDC(NDS)-176/GI, INT(85)-9]. The participants recommended a second stage of this exercise on irradiated molybdenum foils, one set to be irradiated at LLNL for long life activity measurements and the other set to be irradiated locally in each laboratory for the short life activity measurements. This part of the exercise is currently underway. The third and final research co-ordination meeting of this CRP is planned for the week of 27-31 May, 1986 at Dubrovnik, Yugoslavia.

B.2.3. Measurement and Analysis of Neutron Emission Spectra from (p,n) and (α ,n) Reactions

This CRP was approved by the INDC at its last meeting in October 1984 and by the IAEA in early 1985. The programme was discussed with a few prospective participants at an informal meeting during the Santa Fé conference in May 1985 and invitations to join the programme were sent out in August 1985: three research agreements (U.S.A., FRG and Austria) and three research contracts (Brazil, China and India) were concluded. Two more research agreements are under negotiation. The first meeting of this CRP is planned for the week 24-28 June 1986 in Vienna.

B.2.4. Gamma-ray Standards for Detector Calibration

The need for high precision values of gamma-ray energies and their associated emission probabilities for the efficiency calibration of detectors used in gamma-ray spectrometry has received significant attention at three recent Agency-sponsored nuclear data meetings. A standard set of such values is of universal importance in all nuclear experimental applications requiring the exact measurement of the energy and intensity of gamma rays. In response to recommendations from these meetings and from the INDC, the Agency has initiated a Coordinated Research Programme on gamma-ray standards for detector calibration.

The objective of this CRP will be to produce a single internationally-produced file of carefully evaluated decay data suitable for detector efficiency calibration. Although a number of reference data sets for this purpose have been developed and are currently in use in various laboratories, it has become increasingly apparent that there is a need for one universally-accepted file of high-precision radionuclide decay data to serve as an international reference standard.

In preparation for this CRP, NDS convened a Consultants' meeting in May 1985 to review the status of decay data for x- and gamma-ray emissions used in detector calibration. The Summary Report of that meeting has been published in INDC(NDS)-171/GE.

B.2.5. Validation and Benchmark Testing of Actinide Nuclear Data

This CRP had its second Meeting on 14-16 October in Varna, Bulgaria. See report INDC/P(86)-4. The CRP now has 6 participants from Brazil, Bulgaria, P.R. China, India, USSR, Yugoslavia. The work of the participants can be summarized as follows:

Brazil and Yugoslavia: Creation of a 640-group data file (tape available) from all available actinide evaluations (including UKNDL and KEDAK formatted libraries), comparison of evaluations via integrated quantities which, where possible, are also compared with experimental data. (A preliminary report is available).

Bulgaria: Multilevel analysis of Pu-239 and testing in comparison with integral experiments. (See Santa Fe proceedings).

China: Evaluation of higher actinides. (A data file on Am-242 is available).

India: Th-cycle data: evaluation of an improved data file for Th-232, based on benchmark tests and differential data evaluation. (Data file not yet available).

USSR: New evaluations for U-235, Pu-239, 240, 241, 242. (Data files available).

A third meeting of this CRP has been tentatively planned for the first half of 1987.

C. DATA PROCESSING AND EXCHANGE

C.1. Data Centre Network Coordination

C.1.1. Nuclear Reaction Data (NRD)

C.1.1.a) Nuclear Reaction Data Centre Network

The co-ordination meetings of the network of data centres for nuclear reaction data ("NRDC Meetings") have taken place, for some time, at intervals of approximately 18 months. This proved to be too long of an interval for the technical items to be fully discussed and agreed upon.

Consequently, it was agreed to have

- every second year a "full" NRDC Meeting with the presence of centre heads and technical staff, hosted in turn by one of the centres, and
- in the years in between a "technical" NRDC Meeting with the participation of technical staff only, always held in Vienna, (at no cost to the Agency).

All meetings have a duration of 3 days (instead of the previous 5 day meetings).

The first "technical NRDC Meeting" took place on 19-21 September 1984 in Vienna. The summary record is included in "Memo CP-D/131" [same as INDC/P(86)-5]. The discussions concentrated primarily on details and Manual updates of CINDA and WRENDA. A significant re-organization of the flow of the CINDA information exchange among the centres was discussed (and later implemented, see items C.1.1.b) and C.2.1.a). The next Technical NRDC meeting is planned for October 1986.

The 8th NRDC-Meeting with participation of centre heads and technical staff was hosted by the NEA Data Bank in Saclay, 9-11 October 1985. For the report on this meeting see INDC(NDS)-178.

The network of data centres contributing to EXFOR, now includes

- for neutron data: the traditional "Four Centres" NNDC, NEA-DB, NDS, CJD,
- for charged-particle reaction data: CAJaD, NDS, RIKEN and, since recently, the charged-particle group of the Chinese Nuclear Data Center of the Institute of Atomic Energy, Beijing,
- for photonuclear data: CDFE (Moscow State University) with very few contributions from NDS.

(NNDC contributed significant EXFOR files with earlier compilations of charged-particle and photonuclear data).

Some of the major items, that were not only discussed at the meeting but which were dealt with also by inter-centre correspondence throughout the year, are summarized in the following paragraphs.

C.1.1.b) The CINDA network

The responsibilities of the CINDA network members have been restructured as follows:

- Previously, NEA-DB maintained the master file (later on also NNDC maintained an identical master file), and the three other centers submitted their entries to NEA-DB and received copies of the master file.
- In the future, each of the four centers will be fully responsible for maintaining its part of the master file and will send tape copies of its updates to the other three centers.
- The CINDA retrievals from which the CINDA books are produced, were previously prepared at the NEA Data Bank and shipped to NDS for book production. In the future, the entire book production (including the retrieval of the entries to be included in a book) will be done at NDS, on behalf of the four centers.
- Status of the transition: All CINDA computer codes have been rewritten at NDS and CINDA-86 will be produced according to the new scheme. These changes will not affect the content or the publication frequency of the CINDA book.

- For the time being, NDS still takes care of the processing of CJD entries. CJD is preparing to take over the full responsibility for the USSR part of the CINDA master file; including stays of CJD staff at NDS.

C.1.1.c) Neutron data

The neutron data EXFOR operation is now routine, requiring a constant level of manpower for compilation, exchange, file maintenance, and correctness and completeness checking. Due to the limited number of staff, certain data categories, such as data involving polarized neutrons or neutron-induced gamma spectra, though considered to be important, are not compiled systematically.

ENDF/B-5 format is recognized as the international standard for evaluated data but ENDF/B-4 continues to be used as well. The new situation in the US where ENDF/B-6 evaluations will have no release restrictions, has opened new possibilities for international co-operation in the field of neutron data evaluation.

C.1.1.d) Charged-particle Nuclear Data

For charged particle nuclear data, the main EXFOR compilation work is done by CAJaD. It was agreed at the 8th NRDC Meeting, that CAJaD will also co-ordinate the compilation efforts of the charged-particle data compiling centers. (This has been a problem in the past, because the distribution of CPND compilation was not based on geographical criteria but on physics criteria, creating overlap and duplication of effort which could not be avoided).

Priorities of data to be compiled have been widened as a result of the increasing data requirements for radiotherapy purposes, including selected differential data which had not been compiled in EXFOR until now.

C.1.1.e) Photonuclear Data

CDFE (Moscow) is the only active centre which compiles photonuclear data in EXFOR format, and which publishes CINDA type bibliographies; it would be most desirable to have at least one more photonuclear data centre (in US, Europe or Japan) to join the EXFOR network in this field.

C.1.2. Nuclear Structure and Decay Data (NSDD)

The international nuclear structure and decay data (NSDD) network consists presently of 17 evaluation groups in 11 Member States and 2 international data service centres. It aims at a complete and continuous nuclear structure data evaluation of all isobaric mass-chains on a six-year cycle, the continuous publication of these evaluations and their dissemination to the scientific community. The evaluated mass-chain data resulting from this concerted international effort are published in Nuclear Physics A and the Nuclear Data Sheets, and comprise the currently recommended "best values" of all nuclear structure and decay data. The international NSDD network has evolved from the pioneering work in the late forties and early fifties by physicists from the California Institute of Technology (Pasadena), the Rijksuniversiteit at Utrecht

(Netherlands) and the Nuclear Data Group in the United States (Washington and Oak Ridge). The US effort is coordinated by the US Nuclear Data Centre at the Brookhaven National Laboratory.

Periodic meetings of this network have the objectives to maintain the coordination of all centres and groups participating in the compilation, evaluation and dissemination of NSDD, to maintain and improve the standards and rules governing NSDD evaluation, and to review the development and common use of the computerized systems and data bases maintained specifically for this activity.

The seventh meeting of this network is scheduled to be convened by NDS at the CEA in Grenoble, France, 2-5 June 1986.

C.1.3. Other Data Fields

C.1.3.a) Fifth meeting of the A+M Data Centre Network

This meeting was held at Stanford University in California on 22-23 July. The Summary Report of this meeting is published in INDC(NDS)-174/GA.

The main achievements of this meeting were:

- Decided to include current activities of the A+M data centres in the Work in Progress section of the IAEA Bulletin.
- Decided to defer the publication of CIAMDA 85 to the middle of 1986 to allow additions to be included from all centres.
- Decided on a concerted effort by the data centres to identify all A+M collision data sets considered to be evaluated or recommended and publicize this list in the Nuclear Fusion journal.
- Performed a periodic review of the A+M EXFOR dictionaries.
- Initiated an effort to compile a list of processes in atomic interactions and their definitions.

C.1.3.b) Advisory Group Meeting on Atomic Data for Fusion Plasma Modelling

An Advisory Group meeting on Atomic Data for Fusion Plasma Modelling was convened at IAEA Headquarters, on 18-20 September 1985, on the recommendation of the International Fusion Research Council Subcommittee on Atomic and Molecular Data for Fusion. The purpose of the meeting was to review the available atomic collision data relevant to fusion plasma modelling, with emphasis on processes involving iron and its ions. Fourteen experts from five Member States attended the meeting, representing the most active research groups in both the atomic collision physics and plasma modelling communities. The participants reviewed the status of data in the relevant areas of atomic physics and made specific recommendations regarding the use of these data in plasma modelling calculations. The Summary Report of this meeting has been published in INDC(NDS)-177/GA.

C.1.3.c) Materials Properties Data for Fusion

A Specialists Meeting on Materials Properties Data for Fusion was held at IAEA Headquarters on 24-25 April 1985, at no cost to NDS and with minimal NDS manpower involvement. The meeting was attended by two national representatives and two representatives from the INTOR Workshop.

The objective of this meeting was to survey the existence of numerical data on thermophysical, chemical, mechanical and tritium-related properties of solid breeder materials for fusion reactors. The available data were to form the initial input to an international data base of material properties for fusion reactor technology. At the same time it was to provide an example of a possible common numerical data file for materials properties data which are submitted periodically as part of National Reports to the IAEA INTOR (International Torus) Workshop.

To summarize, the meeting achieved the following:

- Reviewed the availability of materials properties data on solid breeders published in the open literature in numerical form;
- Decided on the solid breeder materials and the specific material properties which should be included in an initial data compilation;
- Discussed and approved the format and structure of a data base for materials properties proposed by the IAEA; and
- Supported the IAEA proposal to formulate and establish a data file of numerical material properties data for solid breeder materials, with emphasis on the requirements of the INTOR workshop.

Because of the shortage in manpower, follow-up of this initial activity could not be implemented by NDS.

C.2. DATA PROCESSING

C.2.1. Data Compilation and Exchange

C.2.1.a) CINDA

CINDA data compilation (i.e. scanning of literature and preparing CINDA entries) for all countries outside OECD and USSR, is part of a continuing routine. Difficulties arose from restrictions in the budget of the Vienna International Centre Library, when it stopped the subscription to several translations of USSR journals that had been scanned for CINDA regularly by NDS. On the other hand, the processing of CINDA entries has become easier due to the new CINDA co-operation scheme by which NDS maintains its own CINDA master file (compared to the previous procedure by which NDS entries were entered to the CINDA master file at Saclay).

C.2.1.b) EXFOR

- Experimental neutron reaction data

During the last few years compilation of experimental neutron reaction data produced in the NDS service area was complete and up-to-date. In addition, many of the data compiled earlier were updated in close co-operation with the authors who receive proof copies of their data as compiled in EXFOR. Special attention is given to error analysis and standard reference data. Data completeness checks are co-ordinated with the NNDC schedule for the production of cross-section handbooks.

- Charged particle and photonuclear data

All EXFOR files continue to be updated; new impetus to the charged-particle nuclear data compilation (EXFOR-D) was given by contributions of the Nuclear Data Group at RIKEN (Japan) and the Institute of Atomic Energy in Beijing (China), both of which have joined the CPND network.

The EXFOR compilation of charged-particle reaction data and photonuclear data by NDS continues at a low rate with emphasis on neutron production reactions.

- The EXFOR-INDEX

A new EXFOR-INDEX file has been made available as a new service to users of EXFOR data. In the past, it was difficult for an EXFOR user (e.g. an evaluator) to check whether his EXFOR retrieval on a given topic was still up-to-date. The EXFOR-INDEX provides an easy cross-check, and the needed information. The format of the EXFOR-INDEX file is described in IAEA-NDS-66.

C.2.1.c) Evaluated Data

Evaluated data files held by NDS, continue to grow in size and number.

- The Livermore Evaluated Nuclear Data Library (ENDL-84) is the newest complete library of evaluated data available through the NDS in the ENDF/B-V format; it is documented in IAEA-NDS-11, Rev. 4, March 1985.
- A new version of the International Reactor Dosimetry File, IRDF-85, was issued and documented in IAEA-NDS-41 Rev. 1. It includes 640-group data derived from ENDF/B-5 Rev. 2 (dosimetry and gas production file), two radiation damage files for iron, and 10 benchmark neutron spectra from INDL/V.
- A new version of the IAEA Nuclear Data Library for various neutron data evaluations, INDL/V(85), was issued and documented in IAEA-NDS-31 Rev. 3. It consists of revisions to nearly all evaluations included in the previous version of this library, and new evaluations from the USSR, China, GDR, Austria, Poland, Romania and others. This file comprises now 196 materials. A supplement to INDL/V(85) was issued in Spring 1986.
- A Chinese evaluated data library, CENDL (in ENDF-4 format) was improved by two Chinese scientists on IAEA fellowships (Liang Qichang and Shen Linxing) from the Chinese Nuclear Data Center of the Institute of Atomic Energy in Beijing, during a six-month stay at NDS. This library is documented in IAEA-NDS-61.

C.2.2. Generation of special data bases and handbooks

C.2.2.a) Nuclear Activation Data

A Handbook on Nuclear Activation Data, composed of thirteen individually authored chapters summarizing the most recent nuclear data pertinent to activation analysis, has been submitted for publication and is expected to be published in the form of an IAEA Technical Report in 1986.

The Handbook contains the following individual data compilations:

- Standard Reference Data
 - Nuclear Properties
 - Monitor Reactions
 - Neutron Source Standards
 - Production of Monoenergetic Neutrons between 0.1 and 23 MeV
 - The Neutron Spectrum of Spontaneous Fission of Californium-252
 - Decay Data for Radionuclides Used as Calibration Standards
- Neutron Activation
 - Thermal Neutron Cross-Sections and Infinite Dilution Resonance Integrals
 - Fast Neutron Activation
 - Data for 14 MeV Neutron Activation Analysis
 - Activation Cross-Sections Induced by Fast Neutron
 - Californium Spectrum Averaged Neutron Cross-Sections
- Charged Particle Activation
 - Calculation of Excitation Functions for Charged Particle Induced Reactions
 - Activation Cross-Sections for Light Elements Li to S
 - Thick Target Yield Curves
- Photonuclear Activation Cross-Sections

C.2.2.b) Heavy Element Radionuclide Decay Data

The results of the seven-year coordinated research project (CRP) (see B.2.1.) on "The Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data" will be published as an IAEA Technical Report in the spring of 1986. The results of the work undertaken by the CRP are presented in two parts. Part I takes the form of data tabulations with specific reference to the measurements and evaluations performed by the CRP participants and the data which they recommend; these consist of listings of recommended half lives and branching fractions, gamma-ray transition energies and emission probabilities, and alpha radiation energies and emission probabilities. A complete set of recommended heavy nuclide decay data is given in Part II, including data that have originated from sources other than the CRP.

C.2.2.c) Nuclear Data for Radiation Therapy

Based on the summary and recommendations of the Advisory Group Meeting on "Nuclear and Atomic Data for Radiotherapy and Related Radiobiology", held September 1985, NDS has started to formulate an activity on nuclear and atomic data for radiation therapy. Contact has been established with the International Commission on Radiation Units and Measurements, ICRU, on the required atomic data. NDS plans to organize a Coordinated Research Programme on neutron nuclear data for radiotherapy in 1987 or 1988.

C.2.2.d) Nuclear Data for Radioisotope Production for Medical Applications

NDS has initiated a survey on the current status of excitation functions and availability of the numerical values of more than 200 main reactions required for radioisotope production. Included in this survey are the daughter nuclides and the various means of production using incident particles with different energies. A Consultants' meeting to review this field is planned for 1987.

C.2.2.e) Nuclear Data for Fusion Neutronics Calculations

In response to a standing request from INTOR, NDS maintains a compilation of evaluated neutron cross section data for fusion neutronic calculations; the current compilation, INDL/F-85 is available on magnetic tape on request.

C.2.2.f) Nuclear Data for Safeguards

Compilation work on the handbook of "Nuclear Data for Safeguards" has started and plans for its publication have been made. In order to make the handbook available to safeguards users as soon as possible, a first version is planned to be published in 1986. This version will contain data readily available to NDS and will be updated as further information and data are received. The handbook will be published in loose-leaf form to facilitate updating and revising.

C.2.3. Data Base Management

C.2.3.a) Systems development

In order to minimize the amount of manual data checking by NDS physicists, the data checking programs for evaluated data (in the ENDF/B format), EXFOR, CINDA and WRENDA have been significantly updated to improve automatic error detection. In addition, graphic output has been extensively used to detect errors in evaluated data. Work on the computation format for experimental data has continued and graphic display is available for experimental data. Also available is a program to interactively plot evaluated cross sections from the ENDF/B format and to optically allow the evaluated data to be compared to experimentally measured cross sections.

The NDS CINDA system has been completely rewritten. In contrast to the old system where the CINDA master file was centralized and maintained at the NEA-DB, the new decentralized system provides that each of the four centres maintain the partial master file for its geographic area, and that NDS produces the books from these four partial files.

C.2.3.b) Intercomparison of data processing codes

The results of the IAEA project on the intercomparison of the results of data processing code calculations, which has been conducted over the last five years, has been published as INDC(NDS)-170, May 1985. Results of this project have demonstrated that (1) all participating codes initially contained one or more errors, (2) processing codes have now been significantly improved as a result of this study, (3) users of codes who have not yet submitted their codes to this intercomparison exercise are encouraged to do so.

C.2.3.c) Use of Personal Computers

A major effort has been undertaken to convert ENDF/B pre-processing codes to the IBM PC (personal computer). The ever decreasing PC prices and their increasing capacities offer a cost-effective capability to developing Member States to perform these calculations without dependence upon the availability of main-frame computers. In addition, PC's have proven to be an efficient tool in the compilation and evaluation of smaller sets of data for specific areas of nuclear data applications.

D. DATA SERVICES AND TECHNOLOGY TRANSFER

D.1. Data Centre Services

D.1.1. Documentation and User Services

The services of NDS are advertised to its customers by the "IAEA Nuclear Data Newsletter" of which more than 3 000 copies are distributed at least once a year in intervals that depend on the rate at which important new material is received at NDS. Attached to the Newsletter is a return postcard by which data, reports or other information can be requested.

In order to improve the data services offered to NDS customers, the receipt of new data files or updates to older files initiates a search of the standing requests recorded in the computerized Request Log, resulting in the dispatch of the new data to the requestor.

Documentation reports, issued in the IAEA Nuclear Data Services report series (with report code IAEA-NDS-...), which describe the format and content of data files, are now available for all data files kept at NDS. These reports, kept up-to-date and continuously improved, are sent together with the data files requested from NDS.

Data retrievals in the EXFOR, ENDF/B and some other formats are available in "standard format" for computer processing, or in "edited format" for easy reading, either on tape or in the form of listings. Graphical computer plots can also be provided. These services are provided primarily to users in the NDS service area.

D.1.2. Data Requests

As part of its function as a data centre, NDS disseminates on request nuclear data, data processing computer programs and reports to users in Member States within its service area¹, as well as to other requestors in other countries. During 1985, NDS has received 844 requests, which amounts to more than three requests per working day.

¹ The IAEA/NDS service area comprises Eastern Europe (except the USSR), Africa, Asia (except Japan), Latin America, Australia and New Zealand.

A "request", as interpreted in the statistics, is defined as any query received by NDS for any one of the following specific categories of experimental data, evaluated data, bibliographic retrievals (e.g. from the CINDA master file), documents and computer programs. For example: one letter asking for experimental and evaluated data would count as two requests, or one letter asking for 10 EXFOR data sets would count as one request.

Request statistics for each of the considered categories, and statistics showing the total number of requests handled by NDS for each of the last 21 years are given in Table I. Figure 1 shows the request statistics since 1965 in terms of number of requests per year averaged of 3-year periods (i.e., the value for 1985 is the average over the years 1983, 1984 and 1985).

D.1.3. Data Dissemination

Data dissemination statistics are designed to show what data and associated data information have been sent out as a result of requests received by NDS. Numerical data are normally quantified in terms of "data sets". A "data set" is defined as a set of numerical data of a given type for a given energy range which resulted from a specific data measurement or evaluation. For evaluated data, a data set comprises all data given under one "MAT" number in a given evaluated data library; for EXFOR, a data set comprises all data combined in an EXFOR sub-entry (excluding the first BIB subentry).

Considering both experimental and evaluated data, a data set comprises an average of 440 records. The dissemination statistics for data, data processing codes and reports sent out during 1985 are as follows:

	<u>1985</u>
Sets of experimental nuclear reaction data (EXFOR subentries)	25 544
Sets of evaluated nuclear data	19 773
Total number of megabytes (MB) (Experimental + evaluated data)	1 600
Dispatch of data processing computer programs	21
Total number of tapes dispatched to send (above) data and programs	124
Number of individual reports dispatched on request	1 833

This material was supplied to 41 developing and 17 advanced countries

Fig. 1 Nuclear Data Requests
 (Number of requests per year averaged over 3-year periods)

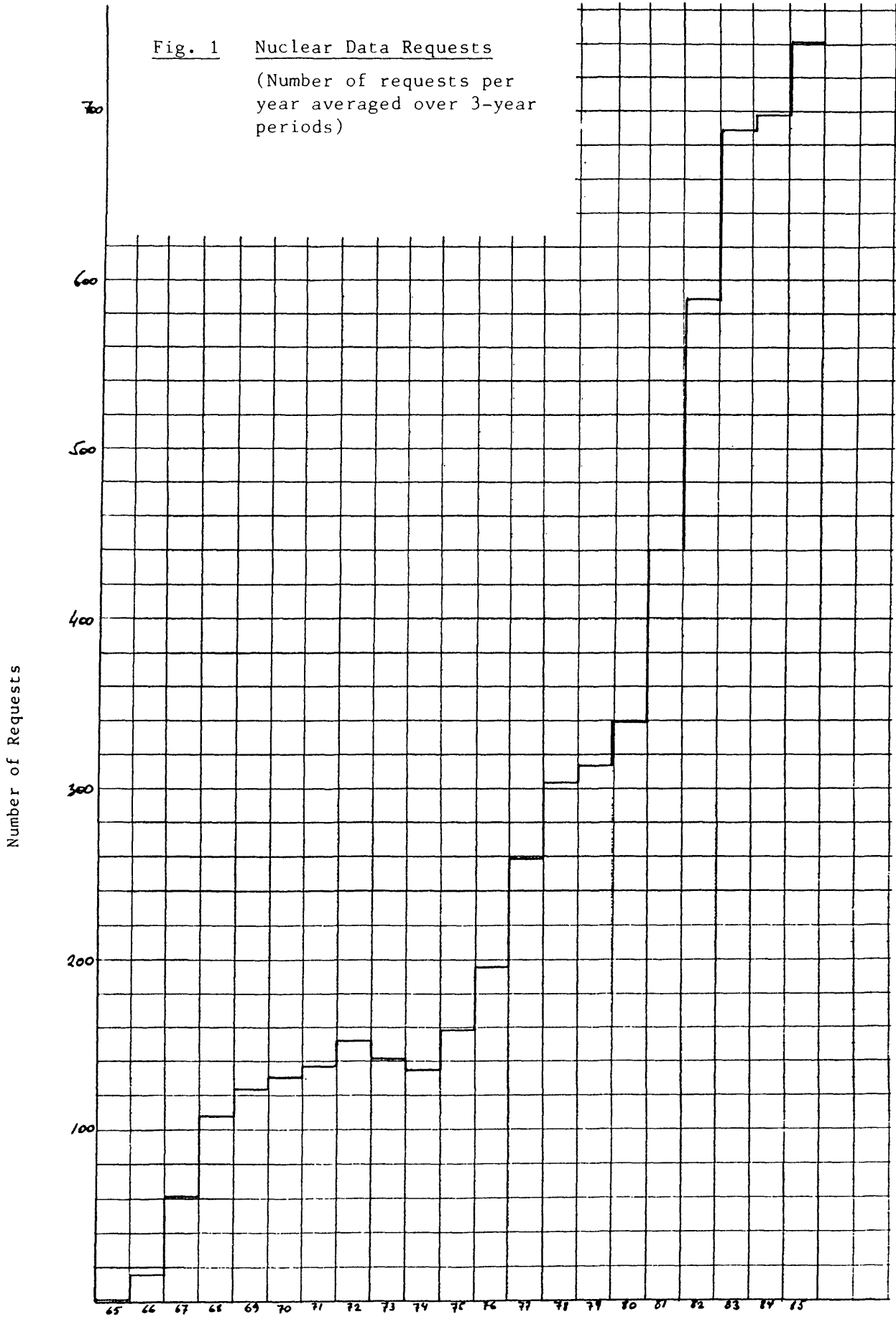


Table I

Data Request and Distribution Statistics 1965 - 1985

Year	Request Statistics (Number of Requests)							
	Experimental Data	Evaluated Data	Experimental and Evaluated Data	Documents	Other*	Totals per year	Totals (Averaged over 3 years)	Totals Cumulative
1965	3	-	3	-	-	3	1	3
1966	40	-	40	-	5	45	16	48
1967	118	-	118	9	8	135	61	183
1968	119	-	119	16	9	144	108	327
1969	48	15	63	25	5	93	124	420
1970	95	20	115	34	8	157	131	577
1971	76	33	109	43	8	160	137	737
1972	48	23	71	60	8	139	152	876
1973	43	22	65	54	6	125	141	1 001
1974	49	24	73	61	6	140	135	1 141
1975	43	49	92	114	3	209	158	1 350
1976	34	43	77	153	9	239	196	1 589
1977	45	49	94	232	3	329	259	1 918
1978	62	71	133	193	17	343	304	2 261
1979	63	93	156	95	18	269	314	2 530
1980	40	86	128	239	42	407	339	2 937
1981	59	185	244	369	31	644	440	3 581
1982	76	174	250	403	60	713	588	4 294
1983	52	115	167	508	45	713	690	5 007
1984	54	113	167	462	38	667	698	5 674
1985	24	221	245	587	12	844	741	6 518

* Since 1978 this category contains exclusively data processing computer programs; all others, including bibliographies, are included under documents.

D.2. PUBLICATIONS

- D.2.1. In the course of the year, NDS distributes approximately 60-70 INDC reports, most of them on behalf of the Member States. Included in the INDC report series are also reports which originate at the NDS and which serve to document meetings and results of projects conducted by NDS. A list of INDC(NDS) and INDC(SEC) reports published by NDS in 1984 and 1985 is given in Appendix B.
- D.2.2. The Nuclear Data Newsletter continues to be published about once a year (or more often when important new data were received that must be announced). Its distribution exceeds 3000 in the NDS service area. To OECD countries and USSR it is distributed only upon request (ca. 250 copies) in order not to interfere with the services of the other centres.
- D.2.3. IAEA-NDS documents
For each data library that is distributed there is an "IAEA-NDS-..." document describing contents and format of the data library for the information of the customer. No tape is sent out without such a document attached. See IAEA-NDS-7 for an index to all data libraries available and IAEA-NDS-0 for an index to all IAEA-NDS-documents.

D.3. TECHNOLOGY TRANSFER TO DEVELOPING COUNTRIES

D.3.1. Interregional Project on Training in Nuclear Measurement Techniques and Applications

This Technical Co-operation Project is now formally in its fifth year, however, significant activities under the project started only towards the end of 1982, hence, in most of the laboratories the project is less than three years old. Its technical objectives are training in accurate nuclear measurement techniques through transfer of technology and know-how required for nuclear data measurements and associated development of nuclear instrumentation and techniques, to less advanced laboratories in developing countries. Twenty five developing and seven developed countries are currently participating in the Project.

As part of the Agency's evaluation of technical co-operation projects, this project has undergone exhaustive evaluations through the stages of a desk evaluation review [IAEA-DER 84/03] followed in 1985 by an "In-depth Field Evaluation" of the programme at six selected laboratories by outside experts. The desk evaluation report IAEA-DER 84/03 was discussed at the last meeting of the INDC and the members approved the recommendation to carry out the "In depth field evaluation" as suggested in the DER. The INDC recommended a list of names of outside experts for this purpose, and four experts were requested from this list to carry out the field evaluation, (J. Bolde - man, G. Knoll, S. Qaim and B. Rose). This field evaluation [final report IAEA-FER 85/10] has resulted in a recommendation to continue the project in its second phase in a modified and wider scope which would emphasise and encourage training in nuclear measurement techniques utilizing neutron generators/sources and/or small accelerators. A draft proposal for this second phase of the project has been prepared.

D.3.2. Training Courses, Workshops, Conferences

D.3.2.a) International Conference on Neutron Scattering in the Nineties

In cooperation with the Physics Section, NDS helped convene this IAEA Conference which was held at KFA, Jülich, FRG, 14-19 January 1985.

The Agency organized a series of symposia on neutron scattering during the period 1960-1977 because of the importance of that technique in condensed matter research, and to promote the applications of this technique in various branches of applied science and technology. The technological developments that have taken place in this field in the area of new instrumentation and techniques indicate that neutron scattering is poised for a new period of growth in terms of its use in basic research as well as in its applications to applied sciences and industry. The present conference was organized to focus on these new developments in techniques, methodology, instrumentation and sources. These topics were covered by a series of invited review papers as well as by the majority of contributed papers. A number of review papers also dealt with utilization of these techniques and associated instrumentation in condensed matter physics as well as in biology, macromolecules, polymer studies, microemulsions and material science, all of which indicate considerable prospects for industrial applications.

D.3.2.b) Interregional Training Course on Basic and Applied Nuclear Physics

A five week training course on Basic and Applied Nuclear Physics with small accelerators was conducted, jointly with the Physics Section, at Legnaro, Italy, in March-April 1985. The purpose of the course was to acquaint scientists from developing countries with several experimental nuclear techniques. The host laboratory at Legnaro is supported by the Italian INFN (Istituto Nazionale di Fisica Nucleare) and is associated with the University of Padova. Seven scientists from developing Member States participated in the course.

The course contents were arranged into two parts, one part related to x-ray fluorescence (XRF) and proton induced x-ray emission (PIXE) techniques which was meant for all the trainees, while the second part offered an option of either fast neutron physics experiments or experiments on ion beam techniques on material science studies. Four participants took the first option while three took the second option.

The Legnaro Training Course was followed by a Study Tour of Accelerator Laboratories in Italy, FRG, USSR and Hungary, in which a total of 24 scientists participated including six of those who participated in the training course.

D.3.2.c) International US-DOE Conference on Nuclear Data for Basic and Applied Science

This US-DOE conference, held at Santa Fe, N.M., USA, 13-17 May 1985, was part of a series of conferences organised every two years alternatively by the U.S., Europe and the U.S.S.R., in co-operation with the Agency. The Agency's co-operation with these conferences makes them accessible to scientists from the third world countries who do not belong to organisations sponsoring these conferences. This

series of conferences started with the Harwell Conference in 1978, the latest being the Antwerp Conference in 1982. In addition to announcing the conference to all the Member States, the Agency provided partial monetary support to 10 scientists from several developing countries for participation in the conference.

D.3.2.d) Joint IAEA/ICTP Workshop on Applications in Nuclear Data and Reactor Physics

This workshop, held at ICTP Trieste, Italy, 17 February - 21 March 1986, was organized jointly by the Agency's Nuclear Data and Physics Sections and the ICTP. Complementary to earlier Winter Colleges on Advances in Nuclear Theory and Nuclear Data for Reactor Applications held at the ICTP in 1978, 1980 and 1982, this Workshop was designed to familiarize the participants with the present state of the art in thermal reactor physics calculations and associated nuclear data and with computer codes used for such evaluations. The Workshop was attended by 60 participants from 26 developing countries and 5 participants from 4 developed countries.

The first week of the Workshop was devoted to an overview of the importance of nuclear data for nuclear energy and of the processing of nuclear data for thermal reactor physics applications. The four remaining weeks of the Workshop were devoted to the important thermal reactor physics issues such as reactor diffusion and transport theory, in-core fuel management, thermal hydraulics, reactor safety analysis and other topics of importance to research and power reactors. The Workshop was complemented by special seminars given by other IAEA staff members on small and medium power reactors, research reactor core conversion, research reactor safety availability of computer codes from the NEA Data Bank, and by NDS staff on cross section preparation, cross section processing code verification project, ENDF/B pre-processing codes, use of personal computers in applied research, and nuclear data services to developing countries.

The Workshop comprized usually a few formal morning lectures per day introducing the participants to the theory and basic features of each reactor code, followed in the afternoons by practical use of the codes in well-defined computational exercises related to the contents of the morning lectures.

The Trieste Workshop was followed by a specialized one week programme on reserach reactor computer codes organized by the Jozef-Stefan Institute at Ljubljana, Yugoslavia. Attendance of this programme was limited to a small number of selected Workshop participants who were currently active in the use of reactor computer codes. This part allowed the participants to actually utilize reactor computer codes related to an operating TRIGA research reactor.

A full account of the programme and results of this Workshop will be given in a special working paper to the INDC.

D.3.2.e) Interregional Training Course on the Preparation and Processing of Nuclear Data for Nuclear Reactor Calculations

This training course, scheduled to be held in Bombay, India, 31 March - 25 April 1986, is designed to allow current users of cross section processing codes to interact directly with the designers of

the codes. Those code systems were selected for use at this course which are mostly used or can be easily introduced in developing countries. A special report will be issued on this Course, once it is completed.

D.3.3. Technical Assistance Projects

NDS has assumed the responsibility for five African technical assistance projects involving the establishment of nuclear analytical laboratories in developing countries; the five countries are Ivory Coast, Kenya, Nigeria, Sudan and Zambia.

D.3.4. Trainees, Fellows and Cost-free Experts

During the reporting period, the NDS has hosted the following cost-free staff:

Mrs. M. Allab, Professor at the University of Sciences and Technology of Algiers, People's Democratic Republic of Algeria, has participated in the work of the Nuclear Data Section as a cost-free expert since March 1983. Her contribution has been in the compilation and review of charged particle nuclear data needed for medical radiotherapy.

Her work on "Survey of Neutron Energy Spectra and Angular Distributions of the ${}^9\text{Be}(p,n){}^9\text{B}$ reaction for Fast Neutron Radiography", INDC(NDS)-153 (1984) received a good reputation in the neutron therapy field. A modified version of this work was presented at the International Conference on Nuclear Data for Basic and Applied Science, Santa Fe, New Mexico. As part of a survey on pion therapy, Mrs. Allab is currently preparing "A review of π^- production in proton-nucleus collisions from threshold to $E_p=70$ GeV".

Mr. Z.T. Bödy from the Institute of Experimental Physics, Kossuth University, Debrecen, Hungary, stayed one year with NDS on an IAEA fellowship. He prepared two contributions to the Handbook on Nuclear Activation Data, namely Chapter I-B "Standard Monitor Reactions for Neutrons", and Chapter II-B.1 "Data for 14 MeV Neutron Activation Analysis" with J. Csikai.

Mr. Qi-Chang Liang and Mr. Lin-Xin Shen

During their stay at NDS, Qi-Chang Liang and Lin-Xin Shen from the Nuclear Data Center of the Institute of Atomic Energy at Beijing, worked extensively to improve the Chinese Evaluated Nuclear Data Library (CENDL). CENDL was tested using the ENDF/B processing codes and inconsistencies were corrected. In addition, new codes were used to eliminate negative cross sections (due to the use of single-level Breit-Wigner resonances) and negative angular distributions (due to the use of Legendre presentation of angular distributions).

Mr. A. Blokhin from the Obninsk Nuclear Data centre spent three weeks at NDS to study the new CINDA processing codes.

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